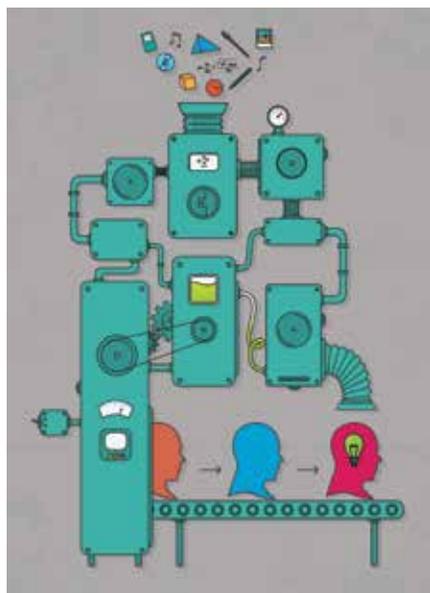


To Own or to Use:

How Product Service Systems Impact Firms' Innovation Behaviour

By Frank Tietze & Erik G. Hansen



Product Service Systems have been advocated to better align firms' economic objectives with societal demands for reduced resource consumption and more ecological products. Below, Frank Tietze and Erik G. Hansen discuss three parameters that differ depending on whether firms sell products to customers or use these as means for providing services.

How Societies Benefit from the Innovation Race

Capitalist societies have become most successful in creating material wealth, not least based on the two central concepts of private property and the virtually unlimited provision of innovative goods by means of modern production systems. However, over the last forty years societies have slowly but steadily started to raise concerns about the tremendous environmental externalities such as resource depletion, waste generation and emissions.

Currently, we observe that an increasing number of firms develop technology-based sharing approaches where users

share, rent or lease products, instead of purchasing them. Within the discussion of currently evolving sharing concepts, the product service system (PSS) concept has gained particular attention. Examples of PSS can be found within both the B2B and B2C sectors in a variety of different industries. Although the discussion about PSS started just recently and academics still debate an accepted definition, the concept is hardly new. Library membership, where users join and get permission to borrow books, can be interpreted as one of the oldest PSS offerings. Today, customers have a variety of choices with examples including 'free floating' (i.e., one-way) car- and bike-sharing solutions, personalised medicine, chemical substance and machinery leasing and turbine operation models in the airline industry. Hence, one should be careful arguing that this is (still) a niche phenomenon. The very fact that multinational car manufacturers such as BMW, Daimler and Volkswagen have recently started to enter the car-sharing business should be taken as indicator of substantial importance to firms.

Whether this development is a reaction to society's environmental concerns in order to maintain legitimacy or rather enabled by technological developments remains to be proven. Most likely it is driven by a complex and dynamic interplay of multiple causes. Either way, what matters is that these approaches have been advocated as having positive impacts on consumer behaviour facilitating more sustainable consumption. For instance, the increasing ease of opportunities to car-share could be argued to have focussed the customer's attention to the cost of car ownership, which in turn has made them reconsider other options such as public transportation.

Within our research, we aim to understand whether PSS not only changes

customer behaviour, but also impacts firms' innovation behaviour and if so, how. While there might be feedback effects from changes in demand patterns, our results indicate that the PSS concept triggers substantial changes within the governance structure of firms leading to stable, long term adjustments of their innovation behaviour.

Innovation: A Double Edged Sword

Firms have widely developed structured approaches and implemented processes to continuously develop innovative products. The cumulative nature of this development has been beneficial in terms of technological progress within different social domains.¹ In today's *consumption societies* however, more and more products are disposed of at the end of their life cycles (or even before) in ever increasing rates resulting in increased costs for society to protect the environment of hazardous effects.²

Despite the undoubtedly positive effects of this innovation race, firms' innovation behaviour can sometimes be accused of contributing to increased negative environmental externalities. While consumers demand the latest innovative products, firms compete with other firms to develop ever more innovative products, the result of which is a shortening of product life cycles creating more waste from their disposal, and thus more externalities.

While the extent of environmental externalities differs among innovations, certainly numerous innovations can be considered 'improvements' in the sense that they cause fewer negative externalities than their predecessors (i.e., previous product generations). For instance, today's flat panel displays consume less energy than traditional cathode ray tube monitors and require less cardboard

for packaging. Since more displays can be shipped in one container due to the smaller size, transport emissions are also reduced. On the other hand, the physical replacement of cathode ray tube monitors and TV sets by flat panel displays has created a huge amount of WEEE (waste electrical and electronic equipment).³ One also has to account for the number of monitors that were substituted with TFT screens before the end of their life cycle.

While there is hardly any product that does not create externalities in any stage of its life cycle (at least at its end), recent societal developments increasingly demand firms to adjust their innovation processes to develop product offerings that substantially reduce the negative externalities.⁴ However, more efficient *eco-products* hardly seem to be sufficient. Rather entirely new approaches and business models are required that cause lasting structural and behavioural changes on consumer and firm levels. In particular, product service systems (PSS) have been advocated as a promising concept. What happens to firms when they attempt to develop and introduce PSS, offering their products to customers for use rather than selling them their products?

Product service systems (PSS) approaches can be interpreted as relation-based business models, where firms engage in continuous relationships with the users of their products.

Our research reveals three parameters that the PSS concept influences, which are explored in turn below. They include the allocation of ownership rights along the product life cycle, the product purpose and the firm's profit function. We suggest that these three parameters impact firms' governance structure substantially. Accordingly, we argue that the PSS concept stands a good chance of shifting firms' innovation behaviour in a direction more aligned with societal demands, and thus to engage in sustainability-oriented innovation.

1. Firms Retain Product Ownership

Traditionally, firms develop and manufacture innovative products to generate value from product sales. During sales transactions, product ownership is transferred to customers in exchange for a payment of an agreed sales price. As a consequence, product innovators have little economic incentive to care about *their* products after ownership has been transferred to customers. Numerous daily examples exist that we are all familiar with such as newspapers, household products, beverages and cars. Exceptions to this rule exist, but often only if firms have possibilities to earn complementary revenues (e.g., through after sales services, such as maintenance, or the sale of complementary equipment) or if forced by governmental regulations.

In such an ownership regime, product responsibilities are decoupled from the manufacturer through a sales transaction where the ownership is transferred to the customer. We label

these transaction-based business models. The transaction-based model relieves manufacturers of their responsibility to care for their products during later phases along the product life cycle (post-sale), particularly the operating and disposal phases. Hence, when these firms determine product specifications within the front end of the innovation process they hardly have incentives to account for the costs occurring for product use and disposal. For instance, bicycle manufacturers rarely develop recycling schemes and leave the disposal of bicycles commonly to their customers. Governments are then needed to cure this market failure deploying policies that force manufacturers through regulations (e.g., WEEE).

In contrast, the situation is different for firms that use their products to provide services. Customers rather sign use contracts, wherefore no ownership transfer takes place, similar to well-known renting or leasing models. In PSS offerings particularly, users sign enduring, open ended contracts (i.e., membership subscriptions). For instance, in the car rental business, customers sign rental contracts commonly for one or a few days. In car sharing models, the operating firm and the users engage in enduring contractual relations with specified termination clauses. Users become only temporary proprietors of products, not gaining ownership rights at any time. Accordingly, Retaining ownership along the product life cycle then turns into a responsibility for firms to care for their products along the use phase, and when disposal becomes necessary. This translates into incentives to consider disposal and recycling aspects within the early conceptual phase of the innovation process.

2. Products Must Not Fail, Ever!

The products which are used in PSS offerings serve a different purpose than if used in transaction-based business models. Firms employing a transaction-based business model sell their products to customers, while PSS innovators retain product ownership and use them as a means for offering services to users. If implemented properly (i.e., not by only adding complementary services to a business logic that still remains to be based on product sales), this is in line with the service-dominant logic thinking.⁵

Having developed and launched a new product, one can assume that any firm will try to optimise that product over time through a number of cumulative and often incremental innovations to optimally fit with its business model. Firms operating a transaction-based business model need to continuously sell products to generate a steady revenue stream. Hence, these firms hardly have incentives to develop products with an exceptionally long product life. Instead, they rather incrementally modify products to optimally fulfill their customer expectations with regard to lifetime, which they might even attempt to influence through marketing campaigns (e.g., provoke 'out of fashion'). If promised that a light bulb would operate for 1000 hours, it should operate at least 1000 hours not to discomfort customers. This however also means

that there is hardly any expectation by the customers that the light bulb should last 2000 hours. Hence, firms have hardly any incentive to develop longer lasting light bulbs. Related to this discussion is the concept of planned obsolescence⁶. If products could last much longer, firms might consider adjusting the optimal product architecture so the product deliberately fails after it has reached the promised and hence expected life time.

Firms using their products for offering PSS do not have to aim for product repurchases. Instead, they need to ensure that the users of their products are not disappointed by the product's performance at any time during usage, assuming that dissatisfaction would increase the likelihood of terminating the contract leading customers to switch to a competitor. Hence, firms developing products to be used within PSS offerings have to optimise their products against different parameters, such as reliability and durability.

3. Higher Usage – not Sales – Means Higher Profits

Due to the different ownership rights allocation along a product's life cycle and different purposes that products serve (whether they are sold or used for PSS offerings), PSS firms have a quite different profit function.

In firms with transaction-based business models, revenues are generally a result of the quantity of sold products multiplied with the per unit sales price. Per unit costs can be commonly split into four components: development costs attributed to a new product, manufacturing costs, costs for marketing, sales and distribution and for continuous optimisation. Accordingly, firms operating a transaction-based business model can maximize their profits by either growing revenues (e.g., through entering new markets or pricing strategies) or through cost-reducing innovations. Common measures to realise cost reductions include the development of process innovations in manufacturing and assembly processes or optimised product design. For instance, following the development and launch of a new vehicle, car manufacturers can reduce manufacturing costs through increased process automation. It is also common to continuously reduce per unit costs through incrementally adjusted design. For instance, expensive, high quality materials are replaced stepwise by cheaper ones with similar or just marginally lower performance properties that are still accepted by the customers (e.g., cars door handles made from aluminum are replaced by those made of plastic with a chrome coating).

In contrast, the profit function of PSS firms differs substantially. Total revenues are rather a function of the duration for which a user utilises one product, multiplied with the unit price per time unit multiplied with the quantity of PSS units. The cost structure is also different. Instead of four components, it includes seven. In addition to the four components mentioned above, PSS firms have to account for the *operating costs* of every PSS unit, the *costs for maintenance* and *for disposal* or *recycling* at the life cycle end. As the PSS profit function includes the cost components embedded in

the profit function of transaction-based business models, PSS firms have similar possibilities to minimise costs (e.g., by reducing manufacturing costs through either replacing expensive with cheaper materials or through process innovations). Though these are also important in PSS firms, the incentives to innovate manufacturing cost reducing measures become less dominant. PSS firms have other opportunities to reduce their total costs, which are rather related to later phases of the product life-cycle. They can reduce their total costs through innovations aimed at reducing operation, maintenance/ repair costs or costs arising from product disposal at the end of the product life cycle.

For instance, the car sharing operator car2go recently implemented the driver education program 'EcoScore' into its vehicles. During a ride EcoScore constantly visualises the driver's 'ecological' driving behaviour. While the software visualises this using growing and shrinking trees to appeal to the driver's eco-awareness, one rather suspects that the software aims (also) to reduce the driver's fuel consumption and thereby minimise the firm's operating costs. Furthermore, the vehicles used by car2go have been recently equipped with a start-stop-automatic that turns the engine off during driving breaks (e.g., at traffic lights or during traffic jams), thereby also reducing operating costs. Having to bear the operating costs also incentivises PSS firms to adopt more advanced technology with benefits on operating costs that are rather difficult to sell to individual customers in a transaction-based model. For instance, car2go reduces operating costs by using electric vehicles offered today in one third of the cities in which car2go operates. The time scale involved in the financial return on these upfront investment costs preclude individual customers from bearing them so falling to the firm (e.g., by realising economies of scale when purchasing the vehicles). Reducing costs for product maintenance can be achieved by adopting a different product architecture. For instance, a modular design could allow easy replacement of those components by the service team that are subject to high abrasion rates. In addition to just replacing components, a modular design allows the easy replacement of certain components with innovative ones (e.g., less energy consuming). Product design adjustments can also be beneficial for PSS operators in order to reduce disposal costs at the end of the product life cycle. Possibilities include the use of innovative natural materials (e.g., Bamboo) and molding techniques to substitute toxic materials within product components that allow composting.

Impact on Firm Innovation Behaviour

In contrast to firms employing transaction-based business models, three important parameters differ in firms that operate products in PSS offerings. Product ownership is not transferred to customers. Products have a different purpose. They should be reused, possibly infinitely instead of being purchased again. The firm has a different (extended) profit

function. These parameters are so substantial, that they will reflect upon firms' R&D objectives and hence on their innovation behaviour.

Product efficiency is now in the self-interest of the PSS firm in order to minimise operating costs. Firms also have institutionalised incentives to design products towards reliability, and specifically durability. This can be observed in many professional bike sharing systems in Germany that have developed bicycles that are optimised for reliability and durability (e.g., strong frames, maintenance free gear pots). Firms also have incentives to design their products to minimise maintenance and, in case product failure is unavoidable, to optimise products for easy repair. Since PSS firms own their products all along their life cycle, they can always access them to upgrade them, and thus have the opportunity to continuously innovate. As these firms still own their products at the end of their life time, they can use *old* products as sources for inexpensive access to particularly expensive raw materials (e.g., rare-earth elements used in cell phones), thus have incentives to design them in a way to be easy disassembled. Hence, although economically motivated (i.e. by cost reduction incentives), a number of resulting incremental technological innovations aimed towards optimisation – though within a PSS paradigm – can cumulatively reduce negative environmental externalities.

Even better, besides benefiting from more reliable and environmentally-friendly operations, firms can suddenly benefit additionally from PSS through *differentiation*. For instance, firms might use sustainable materials primarily in order to reduce recycling costs (e.g., equipping cars with organic seat covers and sustainably-sourced wood applications), but this may turn out to offer customer value in terms of 'eco or wellbeing interior'. Hence, this may make the offering more attractive and even permit charging higher use fees. Overall, such firms' economic objective functions suddenly appear to be better aligned with the objective demanded by environmental economists.

To conclude, PSS changes firms' governance structures through impacting their innovation behaviour in a way that promotes incentives to develop more efficient, consistent, reliable and durable products that are designed to be easily maintained and repaired, which can be easily disassembled and recycled. The extent to which firms realise this innovation potential however depends on additional factors, such as the development of raw material and energy prices and the environmental awareness of users in different cultural and regional contexts as well as legal and regulatory barriers and drivers.

Despite the possibilities of creating a competitive advantage from PPS, strategic management should be aware of the impact that PSS will have on the firm's governance structure. One can expect those firms to fail if they attempt to introduce PSS, but neglect to make the necessary adjustments to their governance structure (e.g., adjusting internal

processes, R&D objectives). These firms should be advised to rather bundle complementary services to their existing product sales business. Firms have the potential to succeed if they understand how to break with path dependency and adjust their existing governance structures, or to run the PSS business in a separate unit to ensure a tight fit with PSS business logic. 

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Notes

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